

CLAIMS

What is claimed is:

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A device comprising:

a substrate comprising a voltage switchable dielectric material; and

a current carrying formation formed on a plurality of selected sections of a surface

of the substrate.

1 2. The device of claim 1, wherein the voltage switchable material comprises a
2 mixture of a binder material, a conductive material, and a cross-linking agent.

1 3. The device of claim 2, wherein the conductive material is dispersed as a powder in
2 the mixture.

1 4. The device of claim 3, wherein the binder material includes a polymer binder, the
2 conductive material includes a metal powder, and the cross-linking agent includes Varox
3 peroxide.

1 5. The device of claim 1, wherein the current carrying formation is electrochemically
2 bonded to the surface of the substrate.

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6. The device of claim 1, wherein the surface of the substrate includes one or more
vias extending through the substrate, the current carrying formation also being formed on
a surface of the substrate defining the vias so that the current carrying formation on the
surface of the substrate is electrically contactable from an opposing surface of the
substrate.

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1 7. The device of claim 1, wherein the current carrying formation includes a plurality
2 of current carrying elements separated from each other by a plurality of gaps, the plurality
3 of gaps defining selected regions where a non-conductive layer was formed on the surface
4 of the substrate.

1 8. The device of claim 1, further comprising a non-conductive layer on the surface of
2 the substrate, the non-conductive layer having gaps corresponding to the plurality of
3 selected sections where the current carrying formation is formed.

1 9. The device of claim 8, wherein the non-conductive layer comprises a dielectric
2 material that is permanent to the ~~surface of~~ the substrate.

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1 10. A device comprising:
2 a substrate comprising a voltage switchable dielectric material, the substrate having
3 a first surface and a second surface opposing the first surface, the substrate
4 further including a vias extending through the substrate;
5 a current carrying formation formed on a plurality of selected sections of the first
6 and second surfaces, and on a surface of the substrate defining the vias to
7 extend an electrical connection from the first surface to the second surface.

1 11. The device of claim 10, wherein the current carrying formation is
2 electrochemically bonded to the first surface, the second surface, and a surface of the
3 substrate defining the vias.

1 12. The device of claim 10, wherein the current carrying formation is formed on a
2 surface of the substrate defining the vias when at least portions of the current carrying
3 formation is being formed on the first and/or the second surface.

1 13. The device of claim 10, wherein the voltage switchable material comprises a
2 mixture of a binder material, a conductive material, and a cross-linking agent.

1 14. The device of claim 13, wherein the conductive material is dispersed as a powder
2 in the mixture.

1 15. A device comprising:
2 a first substrate comprising voltage switchable dielectric material; and
3 a first current carrying formation formed on a plurality of selected sections of a surface of
4 the first substrate;
5 a second substrate comprising voltage switchable dielectric material, the second substrate
6 being adjacent to the first substrate; and
7 a second current carrying formation formed on a plurality of sections of a surface of the
8 second substrate.

1 16. The device of claim 15, wherein the surfaces of the first and second substrates are
2 in electrical contact with each other.

1 17. The device of claim 16, wherein the first substrate includes a vias within the first
2 substrate that accesses the surface of the second substrate, the current carrying formation
3 of the first substrate being formed on the vias to extend electrical contact to the surface of
4 the second substrate from the surface of the first substrate.

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- 1 18. A device comprising:
2 a substrate comprising a voltage switchable dielectric material; and
3 a current carrying formation formed on a plurality of selected sections of a surface
4 of the substrate, the current carrying formation being formed on the surface of
5 the substrate by a process that includes contacting the substrate with a current
6 carrying formation precursor while applying a voltage to the substrate that is
7 sufficient to cause the substrate to be conductive.
- 1 19. The device of claim 18, wherein the current carrying formation includes a plurality
2 of current carrying elements separated from each other by a plurality of gaps, the plurality
3 of gaps defining selected regions where a non-conductive layer was formed on the surface
4 of the substrate.
- 1 20. The device of claim 19, wherein the non-conductive layer was formed from a
2 photo-imageable material that was imaged to define the selected sections of the surface of
3 the substrate, and then subsequently removed from the substrate.
- 1 21. The device of claim 20, wherein the non-conductive layer was formed from a
2 photoresist layer that was exposed with a mask, the exposed regions forming the selected
3 regions of the substrate.
- 1 22. The device of claim 20, wherein the current carrying formation includes a plurality
2 of current carrying elements separated by a non-conductive layer, the non-conductive
3 layer being patterned by a process of silk-screening a dielectric layer onto the substrate
4 according to a pattern that defines the selected sections of the surface of the substrate.

1 23. The device of claim 18, wherein the process includes using an electrode to plate
2 the current carrying formation on the selected sections of the substrate.

1 24. The device of claim 23, wherein the process includes applying a pulsed voltage to
2 the electrode while applying the voltage to the substrate that is sufficient to cause the
3 substrate to be conductive in order to plate the current carrying formation on the selected
4 sections of the substrate.

1 25. The device of claim 24, wherein the process includes applying a rectified pulse
2 periodic voltage to the electrode while applying the voltage to the substrate that is
3 sufficient to cause the substrate to be conductive in order to plate the current carrying
4 formation on the selected sections of the substrate.

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art* 26. The device of claim 18, wherein a minimum voltage needed to cause the substrate
1 to be conductive ranges between 10 volts and 300 volts.
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1 27. The device of claim 18, wherein a minimum voltage needed to cause the substrate
2 to be conductive ranges between 30 volts and 100 volts.

1 28. The device of claim 18 wherein the surface of the substrate includes a vias
2 extending through the substrate, a current carrying layer being formed on a surface
3 defining the vias, the current carrying layer being formed by contacting the surface
4 defining the vias with a current carrying formation precursor while applying a voltage to
5 the substrate that is sufficient to cause the substrate to be conductive.

1 29. The device of claim 28, wherein the current carrying layer is formed on the surface
2 defining the vias during the process that forms the current carrying formation on the
3 substrate.

1 30. The device of claim 28, wherein the current carrying layer is formed on the surface
2 defining the vias during a process that includes using an electrode to plate the current
3 carrying formation on the selected sections of the substrate while a voltage is applied to
4 the substrate that is sufficient to cause the substrate to be conductive.

1 31. A device comprising:
2 a substrate comprising a voltage switchable dielectric material, the substrate having
3 a first surface and a second surface opposing the first surface, the substrate
4 including a vias that extends between a first surface and a second surface of the
5 substrate; and
6 a current carrying formation formed on a plurality of selected sections of the first
7 and second surfaces, and on a surface of the substrate defining the vias, the
8 current carrying formation being formed on the substrate by one or more
9 processes, each process including contacting the substrate with a current
10 carrying formation precursor while applying a voltage to the substrate that is
11 sufficient to cause the substrate to be conductive.

1 32. The device of claim 31, wherein a first current carrying formation on the first
2 surface and a second current carrying formation on the second surface of the substrate
3 each include a plurality of current carrying elements separated by a plurality of gaps, the
4 plurality of gaps on each of the first and second surfaces defining selected regions where a
5 corresponding non-conductive layer was formed.

1 33. The device of claim 32, wherein a first non-conductive layer was formed on the
2 first side of the substrate from a photo-imageable material that was imaged to define the
3 selected sections of the first surface of the substrate.

1 34. The device of claim 33, wherein a second non-conductive layer on the second side
2 of the substrate was formed from a photo-imageable material that was imaged to define
3 the selected sections of the second surface of the substrate.

1 35. The device of claim 34, wherein the first and/or second non-conductive layers were
2 each formed from a photoresist layer that was exposed with a mask, where the exposed
3 regions formed the selected regions of the respective first and/or second surfaces of the
4 substrate.

1 36. The device of claim 35, wherein the process includes using an electrode to plate
2 the current carrying formation on the selected sections of the first surface, second surface,
3 and/or surface of the substrate defining the vias.

1 37. A device comprising:
2 a first substrate comprising a voltage switchable dielectric material;
3 a first current carrying formation formed on a plurality of selected sections of a
4 surface of the first substrate, the first current carrying formation being formed
5 by a process that includes applying a first voltage to the first substrate that is
6 sufficient to cause the first substrate to be conductive;
7 a second substrate comprising a voltage switchable dielectric material, the second
8 substrate being adjacent to or stacked on the first substrate; and
9 a second current carrying formation formed on a plurality of selected sections of a
10 surface of the second substrate, the second current carrying formation being
11 formed by the process that includes applying a second voltage to the second
12 substrate that is sufficient to cause the second substrate to be conductive.

1 38. The device of claim 37, wherein one of the first or second substrates is positioned
2 to contact the surface of the other of the first or second substrates.

1 39. The device of claim 38, wherein the first substrate includes a vias within the first
2 substrate that accesses the surface of the second substrate, the current carrying formation
3 of the first substrate extending through the vias to extend electrical contact to the surface
4 of the second substrate.

1 40. The device of claim 37, further including a first non-conductive layer patterned
2 onto the first surface of the first substrate prior to the process to form the first current
3 carrying formation, a second non-conductive layer patterned onto the second surface of the
4 second substrate prior to the process to form the second current carrying formation, where
5 gaps in the first and second non-conductive layers define the plurality of selected sections
6 where the current carrying formation is subsequently formed on the respective first and
7 second surfaces.

1 41. The device of claim 40, wherein the first and/or second non-conductive layers are
2 formed from a photo-imageable material that is imaged to define the selected sections of
3 the respective first surface and/or second surface.

1 42. The device of claim 37, wherein one of the substrates comprises the voltage
2 switchable dielectric material formed from a first mixture, and another of the substrates
3 comprises the voltage switchable dielectric material formed from a second mixture that is
4 different than the first mixture.

1 43. The device of claim 42, wherein the first and second mixture each include a
2 binding agent, a conductive powder, and a cross-linking agent.

1 44. The device of claim 43, where the conductive powder of each of the first and
2 second mixtures includes an element selected from the group consisting of nickel,
3 aluminum, silver, copper, tin, and gold.

1 45. The device of claim 37, wherein the first current carrying formation is formed from
2 a material having a first composition, and the second current carrying formation is formed
3 from a material having a second composition different than the first composition.

1 46. The device of claim 45, wherein the first and second current carrying formations
2 are each formed from material selected from the group consisting of gold, silver, nickel,
3 tin, and aluminum.

1 47. The device of claim 37, wherein the first substrate is stacked over the second
2 substrate and a third substrate.

1 48. The device of claim 37, wherein the first substrate is placed in an end-to-end
2 orientation relative to the second substrate.

Sub 1 49. A semiconductor device including a substrate upon which circuitry forming the
2 functionality of the semiconductor device is positioned, wherein the improvement
3 comprises:
4 the substrate comprising a voltage switchable dielectric material; and
5 a current carrying formation formed on a plurality of selected sections of a surface
6 of the substrate.

1 50. The semiconductor device of claim 45, wherein the semiconductor device includes
2 devices selected from a group consisting of integrated circuit devices, computer
3 processors, computer readable memory devices, motherboards, and PCB.

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